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Natural Resource Stewardship and Science

Monitoring Aquatic Amphibians and Invasive Species in the Mediterranean Coast Network - 2017 Annual Report

Santa Monica Mountains National Recreation Area

Natural Resource Report NPS/MEDN/NRR—2019/1884

ON THIS PAGE
Western toad (*Bufo boreas*) tadpoles
Photograph by Sarah Wenner, National Park Service, Santa Monica Mountains National Recreation Area

ON THE COVER
Western toad (*Bufo boreas*) amplexus
Photograph by Sarah Wenner, National Park Service, Santa Monica Mountains National Recreation Area

Monitoring Aquatic Amphibians and Invasive Species in the Mediterranean Coast Network - 2017 Annual Report

Santa Monica Mountains National Recreation Area

Natural Resource Report NPS/MEDN/NRR—2019/1884

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Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Abstract

Santa Monica Mountains National Recreation Area, a highly fragmented urban national park, is home to five native stream-breeding amphibians. The location of these species and their abundances are related to the amount of urbanization in the watersheds in which they live. Consistent water inputs from urban run-off into streams assure that non-native invasive species persist and thrive in those streams. The objectives of our long-term monitoring program are to 1) determine the status and long-term trends in abundance indices and percent area occupied by juvenile and adult aquatic amphibians in streams during the reproductive season, 2) determine the status and long-term trends in occupancy and abundance indices of non-native species, and 3) characterize the relationship between urbanization, climate, non-native species and the occupancy and abundance indices of native aquatic amphibians. This report summarizes stream survey data collected during 2017. We present single-season occupancy and detectability estimates, naïve occupancy, and abundance data.

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Introduction

Santa Monica Mountains National Recreation Area (SAMO) is adjacent to Los Angeles, the second largest city in the United States. Ecosystem changes that result from urban development include the destruction and fragmentation of breeding habitat for aquatic amphibians, degradation of air and water quality, altered stream discharge regimes, and the introduction and spread of non-native invasive species. Urbanization of as little as 10% of a watershed can have significant impacts on the distribution and abundance of native amphibians (Paul & Meyer 2001; Riley et al. 2005). A reduction in the distribution of native amphibians in association with increasing levels of urbanization and invasive species has been documented in the Santa Monica Mountains (Gamradt & Kats 1996; Goodsell & Kats 1999; Riley et al. 2005).

Native aquatic amphibian species in SAMO include California newts (*Taricha torosa*), Pacific treefrogs (*Pseudacris regilla*), California treefrogs (*P. cadaverina*), western toads (*Bufo boreas*), and California red-legged frogs (*Rana draytonii*). California red-legged frogs, formerly common in a number of streams in the region (De Lisle et al. 1987), were extirpated from the Santa Monica Mountains in the mid-20th century. This species is now part of a re-introduction effort at SAMO. Non-native aquatic species within SAMO include red swamp crayfish (*Procambarus clarkii*) native to the southeastern United States, bullfrogs (*Lithobates catesbeiana*), and a number of fish species including bass (*Micropterus* spp.), bluegill (*Lepomis macrochirus*), and mosquitofish (*Gambusia affinis*).

The long-term monitoring program for aquatic amphibians in the Mediterranean Coast Inventory and Monitoring Network (MEDN; Delaney et al. 2011) focuses on two metrics: occupancy (MacKenzie et al. 2003) and indices of abundance. Occupancy modeling provides a statistical framework for assessing changes in species occurrence while explicitly accounting for differences in detectability (MacKenzie et al. 2003, 2006). Information from repeated observations at sample units (streams) is used to estimate detectability and adjust occupancy rates for imperfect detection (failure to observe a species that is actually present).

The objectives of our long-term monitoring program are to: 1) determine the status and long-term trends in abundance indices and percent area occupied by juvenile and adult aquatic amphibians in streams during the reproductive season, 2) determine the status and long-term trends in occupancy and abundance indices of non-native species, and 3) characterize the relationship between urbanization, climate, non-native species and the occupancy and abundance indices of the focal native aquatic amphibians.

This report summarizes data collected during 2017. This year we had normal to above average rainfall levels after 4-5 years of extreme drought (Figure 1). We present single-season occupancy and detectability estimates, naïve occupancy data, and abundance data.

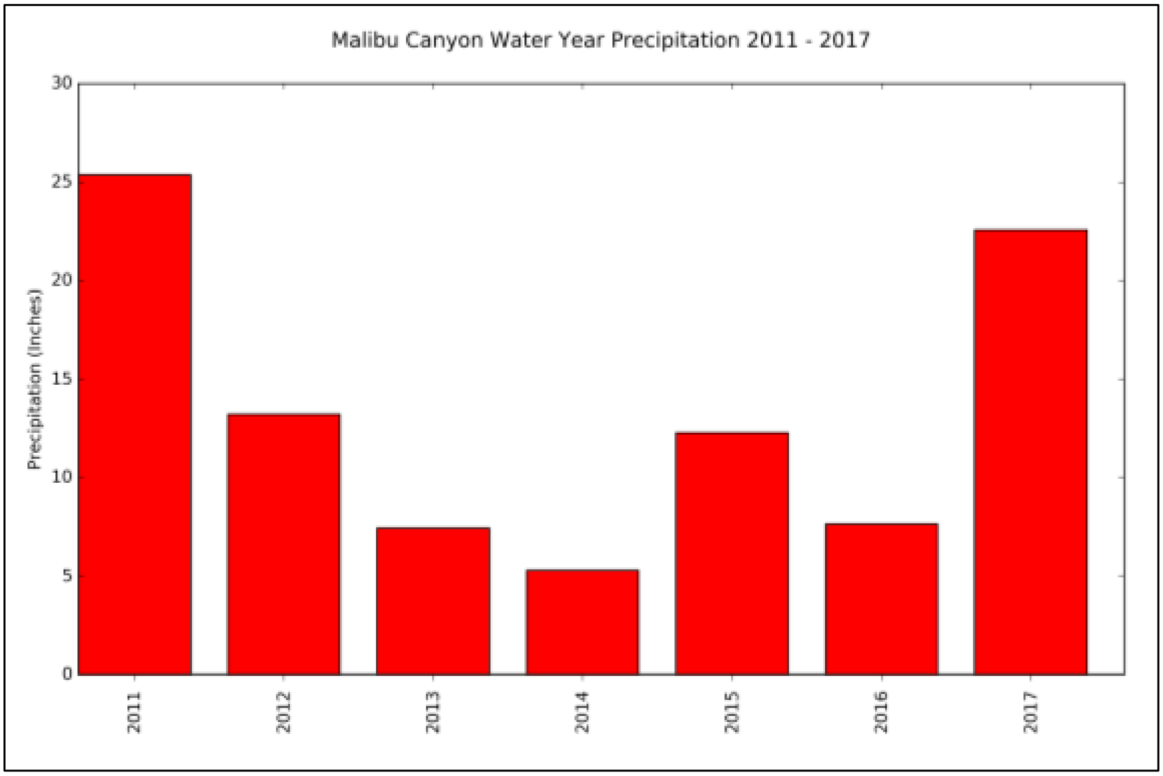

Figure 1. Precipitation (inches) in Malibu Canyon, a central location within Santa Monica Mountains National Recreation Area (data from www.climateanalyzer.org).

Methods

A detailed description of methods for the long-term monitoring of aquatic amphibians in SAMO can be found in Delaney et al. (2011).

Sampling Design and Site Selection

In all, 58 unique locations have been identified for long-term monitoring (Figure 2). These locations include a mix of sites that have been monitored since 2000 (sentinel sites, N=22) and a suite of sites selected using generalized random tessellation stratified sampling (GRTS) (Stevens & Olsen 1999, 2003, 2004) that have been monitored on a rotating basis since 2006 ("R" sites, N=36). The "R" streams are visited following a serially rotating panel design. The 36 "R" sites are divided into three panels consisting of 12 monitoring sites each (R1, R2, and R3). One panel is visited each year for three years. In the fourth year, R1 panel sites are revisited and so on. Sentinel sites were surveyed by the National Park Service and collaborators in 2017 (Figure 3). NPS also surveyed R2 sites in 2017 (Figure 3).

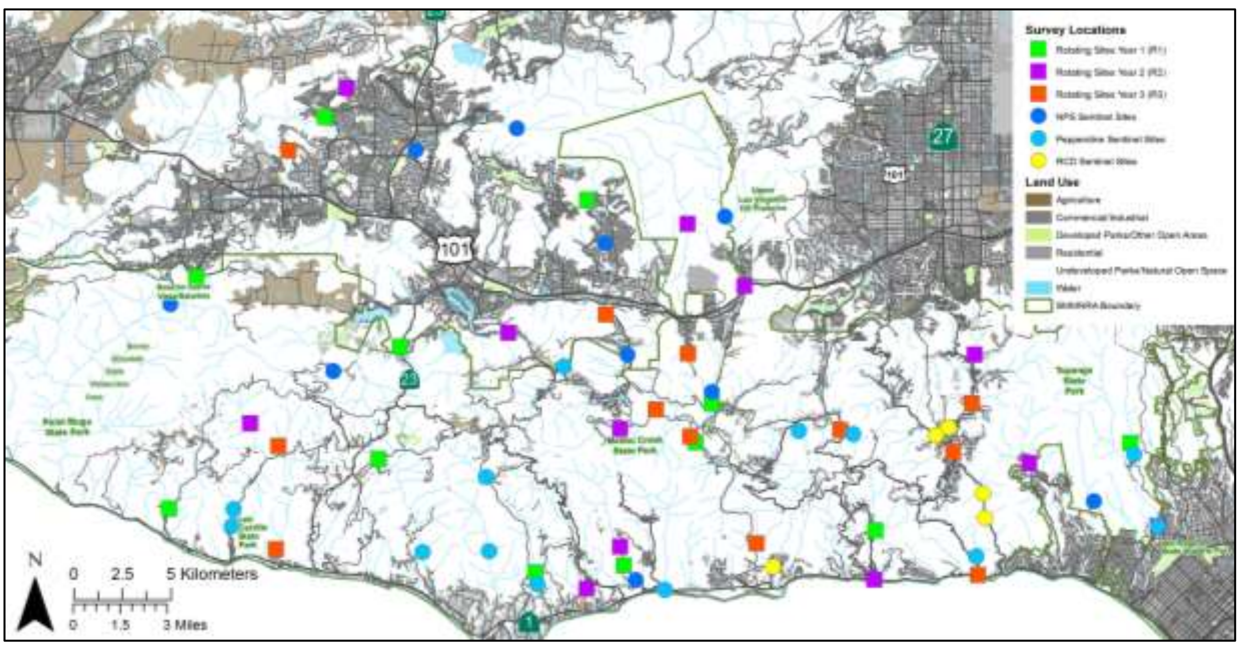

Figure 2. Study area and stream sites for all monitoring surveys.

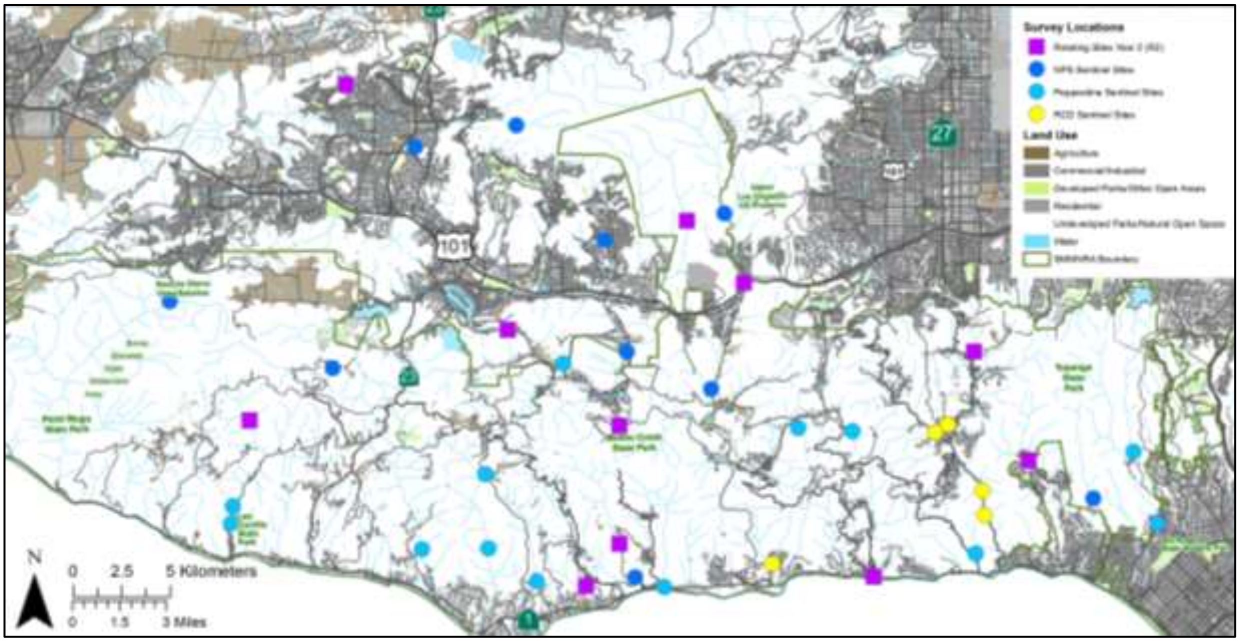

Figure 3. Sentinel sites monitored by NPS, Pepperdine and RCDSMM staff. Rotating sites “R2” were monitored by NPS in 2017.

Sampling Frequency and Replication

Sampling occurs from April to July to capture the breeding seasons of target amphibians. Each sampling location is visited twice in the season: once for an intensive sampling visit, when a full suite of biological and environmental data is collected, and another visit for observation of occupancy by target species (native amphibians and non-native fauna). Either survey type can be done first during the season. The timing of the sampling events are scheduled to coincide with species-specific breeding seasons of the target amphibians, and is somewhat dependent upon year-to-year climate patterns. In very wet years the overall season for sampling may be longer than normal or drier years. Inland low elevation, low gradient streams are most likely to harbor the egg masses and/or larvae of western toads and are sampled early in the season as these often dry up sooner than higher elevation high gradient streams. High gradient or coastal streams are most likely to harbor the larvae of California treefrogs and may be sampled later in the season.

Data Collection

There are two types of surveys done each year at each stream site: presence/absence (not detected) or occupancy sampling, and intensive sampling. To confirm observations, dip nets and Aquascopes are used to find and capture larvae and adults and to verify species identification. Undersides of rocks, submerged logs and floating vegetation are searched for amphibian egg masses. Banks, exposed rocks and floating vegetation are also scanned for juvenile and adult amphibians.

- During occupancy sampling, a team of one to two surveyors begins at the designated starting point and travels upstream 250 meters (m) while recording the presence of any native amphibians or non-native target species.
- During intensive sampling, a team of at least two surveyors begins at the designated starting point, travels upstream for 250 m and collects physical and biological stream data as outlined below.

Physical Data

The field crew measures physical variables of each habitat along the length of the 250 m stream transect. Habitat is categorized into one of four types: pool (slow to non-moving bodies of water); riffle (quick, shallow moving water); run (deeper, slow moving water); and dry. Every change in habitat is considered a "stop" and is recorded as a number sequentially on the field data form. Length and depth of habitat are recorded for the stream segment between stops. Length (m) is measured using a 50 m tape-measure, and depth (cm) is taken at the deepest point in the habitat segment using a meter stick. Habitat conditions (e.g. vegetation type, boulders, erosion) are recorded at each site.

Biological Data

For each target amphibian species, the following are determined and recorded at each stop:

- Abundance estimates using indices (<5, 5-20, 21-100, 101-500, >500) for larvae and juveniles; complete counts for adults and egg masses
- Age class counts (egg, larvae, juvenile, adult)

For each invasive species, the following are determined at each stop and recorded:

- Presence/absence of fish
- Presence/absence of crayfish
- Abundance estimates using indices (<5, 5-20, 21-100, 101-500, >500) of adult and juvenile crayfish

Data Verification, Validation, and Certification

Data were collected by SAMO, MEDN, or partner agency staff and interns and entered into the MEDN Aquatic Herpetofauna Database. Data were quality checked and verified for errors by program staff. Validation queries were run to highlight field values that were not consistent with expected results (i.e., out-of-range values). These values were double-checked against field datasheets and discrepancies were corrected as appropriate and/or noted in the database. All data collected in 2017 have been verified, validated, and certified to ensure they are error-free to the greatest extent possible.

Data Analysis

Naïve occupancy was estimated from presence/absence data taken during the occupancy and intensive surveys conducted at each site. For analysis of occupancy, data from intensive surveys was collapsed to resemble the format of data from occupancy surveys. Single season occupancy estimates were made for each species using intercept-only, zero-inflated binomial mixture models. Occupancy and detection probabilities were estimated using maximum likelihood (MLE's) and numerical optimization. R code, adapted from Royle and Dorazio (2008; p. 117, Panel 3.8), was used to generate point estimates for occupancy and detection. Single season occupancy and detection did not include co-variates, therefore no model selection was needed.

Abundance data were used by calculating the number of stops in the stream that had the same abundance category. For example, we calculated the number of stops in a stream that had an abundance category of 21-100 divided by the total number of stops in a stream, resulting in a proportion of stops in a stream with an abundance category of 21-100. For Pacific treefrog tadpole abundance, we compared the proportion of stream stops in each category in streams with crayfish and without. Significance between crayfish and non-crayfish streams was tested with a non-parametric two-sample Wilcoxen test using R (R Core Team 2018).

Also, the average number of larvae per meter was calculated for streams with and without crayfish. This was calculated by taking the lowest number from our abundance categories (e.g. "5" taken from 5-20), adding the numbers together, and dividing by 250 m (the length of stream surveyed).

Results and Discussion

Pepperdine staff surveyed nine stream sites, the Resource Conservation District of the Santa Monica Mountains (RCDSMM) surveyed four stream sites, and NPS staff surveyed 22 stream sites in 2017 (Table 1). NPS visited several sites that were dry on the initial visit and as there was no rain during the sampling season, these sites were not re-visited (Table 1). RCDSMM did not do presence/absence surveys at certain locations due to administrative issues (Table 1, blank spaces).

One R2 sampling site, Suttphur (Topanga; stream code R2_SUTTPHUR) is located on private property. In 2017 we discovered that it was fenced and the property was occupied, and we were unable to sample. It is unknown what developments in and around the creek were or will be. In good rain years, the creek was good breeding habitat for Pacific treefrogs (HYRE). This site will be replaced with a new site when the Rotating R2 sites are sampled next (2020).

Table 1. Survey dates for each site (Stream Name, Stream Code) by agency (Surveyors). Dates for each Presence/Absence (P/A) and Intensive surveys are shown for each year.

Stream Name	Stream Code	P/A	Intensive	Surveyors
Arroyo Sequit Lower	pepARRSEQL	15-Jun-17	5-Jun-17	Pepperdine
Arroyo Sequit Upper	pepARRSEQU	12-Jun-17	5-Jun-17	Pepperdine
Cold Creek Lower	pepCOLDCRKL	22-Jun-17	9-Jun-17	Pepperdine
Cold Creek Upper	pepCOLDCRKU	03-Jul-17	7-Jun-17	Pepperdine
Malibu	pepMALIBU	13-Jun-17	13-Jun-17	Pepperdine
Newton	pepNEWTON	13-Jun-17	6-Jun-17	Pepperdine
Trancas	pepTRANCAS	24-Jun-17	6-Jun-17	Pepperdine
Tuna Canyon	pepTUNACYN	05-Jul-17	9-Jun-17	Pepperdine
Zuma Canyon	pepZUMACYN	18-Jun-17	8-Jun-17	Pepperdine
Greenleaf	rcdGREENLEAF	–	19-Apr-17	RCD SMM
Old Topanga	rcdOLDTOPA	–	19-Apr-17	RCD SMM
Topanga3200	rcdTOPACYN3200-3700	15-Jun-17	17-Apr-17	RCD SMM
Topanga4500	rcdTOPACYN4500-5000	15-Jun-17	18-Apr-17	RCD SMM
Bulldog	R2_BULLDOG	14-Apr-17	15-Jun-17	NPS
Cheeseboro	R2_CHEESEBORO	28-Mar-17	dry*	NPS
Circle X Grotto	R2_CIRCLEX	08-May-17	14-Jun-17	NPS
Escondido	R2_ESCONDIDO	26-Apr-17	30-May-17	NPS
Las Flores	R2_LASFLORES	13-Apr-17	30-May-17	NPS
Las Virgenes (near 101)	R2_LASVIRGENES	22-Jun-17	26-Jun-17	NPS
Olsen (CLU)	R2_OLSEN	13-Apr-17	dry*	NPS
Rustic Canyon	R2_RUSTIC	18-Apr-17	13-Jun-17	NPS
Santa Ynez Canyon	R2_SANTAYNEZ	18-Apr-17	23-May-17	NPS

* Blue cell shading used when intensive survey date is “dry”.

Table 1 (continued). Survey dates for each site (Stream Name, Stream Code) by agency (Surveyors). Dates for each Presence/Absence (P/A) and Intensive surveys are shown for each year.

Stream Name	Stream Code	P/A	Intensive	Surveyors
Solstice Upper (Sostomo)	R2_SOSTOMA	14-Apr-17	12-Jun-17	NPS
Suttphur (Topanga)	R2_SUTTPHUR	–	–	NPS
Triunfo Creek	R2_TRIUNFO	10-Jul-17	29-Jun-17	NPS
Big Sycamore	S_BIGSYC	29-Mar-17	24-May-17	NPS
Carlisle	S_CARLISLE	25-Apr-17	12-May-17	NPS
Lang Ranch Upper	S_LANRNCHN	01-May-17	10-May-17	NPS
Erbes	S_LANRNCHS	05-Jul-17	07-Jul-17	NPS
Las Virgenes Lower	S_LLASVIR	22-Jun-17	23-Jun-17	NPS
Medea Creek (Lower)	S_LMEDCRK	19-Jun-17	20-Jun-17	NPS
Solstice Canyon	S_SOLSCRK	26-Apr-17	31-May-17	NPS
Temescal Canyon	S_TEMECYN	27-Apr-17	09-Jun-17	NPS
Upper Las Virgenes	S_ULASVIR	28-Mar-17	11-May-17	NPS
Medea Creek (Upper)	S_UMEDCRK	19-Jun-17	28-Jun-17	NPS

* Blue cell shading used when intensive survey date is “dry”.

Biological Data

Naïve Occupancy

As in other years, Pacific treefrogs had the widest distribution of all of the target amphibian species in 2017 (Table 2). They are found in a wide variety of habitats including many streams that have invasive crayfish and fish present, although they are less abundant (see below).

Western toads were the least detected species in our study area (Table 2). Few of the sampled streams fit the habitat requirements for toad breeding, therefore occupancy is usually the lowest for this species each year.

California newt and California treefrog occupancy appeared to be related to the presence of non-native species in our stream surveys. They were rarely present in streams that had invasive crayfish, fish, or bullfrogs (Table 2). In 2017, the exceptions were Topanga and Trancas Creeks where crayfish, California newts, and California treefrogs coexist.

Table 2. The presence (1) or absence/not detected (0) of each target species at each site in 2017 (intensive and presence/absence surveys combined). The following species and corresponding 4-letter codes were used: Western toad (BUBO), Pacific treefrog (HYRE), California treefrog (HYCA), California newt (TATO), red swamp crayfish (CRAY), and any non-native fish species (FISH). The table is sorted by CRAY to examine patterns of occupancy of other species in relation to crayfish presence. Presence (1) also shown in blue cell shading.

Stream Name	Stream Code	BUBO	HYCA	HYRE	TATO	CRAY	FISH
Arroyo Sequit Lower	pepARRSEQL	0	1	1	1	0	0
Arroyo Sequit Upper	pepARRSEQU	0	1	1	1	0	0
Cold Creek Lower	pepCOLDCRKL	0	1	0	1	0	0
Cold Creek Upper	pepCOLDCRKU	0	1	1	1	0	0
Newton	pepNEWTON	0	1	1	1	0	0
Tuna Canyon	pepTUNACYN	0	1	1	1	0	0
Zuma Canyon	pepZUMACYN	0	1	1	1	0	0
Bulldog	R2_BULLDOG	0	1	1	1	0	0
Cheeseboro	R2_CHEESEBORO	0	0	0	0	0	0
Circle X Grotto	R2_CIRCLEX	0	1	1	1	0	0
Escondido	R2_ESCONDIDO	0	0	1	0	0	0
Las Flores	R2_LASFLORES	0	0	1	0	0	0
Las Virgenes (near 101)	R2_LASVIRGENES	1	0	1	0	0	1
Rustic Canyon	R2_RUSTIC	0	0	1	1	0	0
Santa Ynez Canyon	R2_SANTAYNEZ	0	0	1	1	0	0
Solstice Upper (Sostomo)	R2_SOSTOMA	0	1	1	1	0	0
Greenleaf	rcdGREENLEAF	0	0	1	0	0	0
Old Topanga	rcdOLDTOPA	1	0	1	0	0	0
Big Sycamore	S_BIGSYC	0	1	1	1	0	0
Carlisle	S_CARLISLE	1	1	1	1	0	0
Lang Ranch Upper	S_LANRNCHN	0	0	1	1	0	0
Solstice Canyon	S_SOLSCRK	0	1	1	1	0	0
Temescal Canyon	S_TEMECYN	0	0	1	1	0	0
Upper Las Virgenes	S_ULASVIR	1	0	1	0	0	0
Malibu	pepMALIBU	0	0	1	0	1	1
Trancas	pepTRANCAS	0	1	0	1	1	0
Triunfo Creek	R2_TRIUNFO	0	0	0	0	1	1
Topanga3200	rcdTOPACYN3200-3700	0	1	1	1	1	1
Topanga4500	rcdTOPACYN4500-5000	1	0	1	1	1	1
Erbes	S_LANRNCHS	0	0	0	0	1	1
Las Virgenes Lower	S_LLASVIR	0	0	1	0	1	1

Table 2 (continued). The presence (1) or absence/not detected (0) of each target species at each site in 2017 (intensive and presence/absence surveys combined). The following species and corresponding 4-letter codes were used: Western toad (BUBO), Pacific treefrog (HYRE), California treefrog (HYCA), California newt (TATO), red swamp crayfish (CRAY), and any non-native fish species (FISH). The table is sorted by CRAY to examine patterns of occupancy of other species in relation to crayfish presence. Presence (1) also shown in blue cell shading.

Stream Name	Stream Code	BUBO	HYCA	HYRE	TATO	CRAY	FISH
Medea Creek (Lower)	S_LMEDCRK	0	0	1	0	1	1
Medea Creek (Upper)	S_UMEDCRK	0	0	1	0	1	1
Olsen (CLU)	R2_OLSEN	–	–	–	–	–	–
Number of occupied sites		**5**	**15**	**28**	**20**	**9**	**9**
Percentage of occupied sites		**15%**	**44%**	**82%**	**59%**	**26%**	**26%**

Occupancy and Detectability

Estimated occupancy and detectability was very high for Pacific treefrogs (HYRE) in 2017 (Figure 4). Pacific treefrogs are the most common species of stream-breeding amphibian in the study area and can be found in many habitats, including some of our most urbanized streams. Streams where they were not found were dry or are highly impacted by non-native crayfish and fish. An exception to this pattern is in Temescal Canyon where there are no invasive predators for Pacific treefrogs, but California newts, which are a native predator of treefrogs, reach very high densities.

In 2017, we were able to estimate occupancy and detectability for Western toads. Western toads breed in very still or slow-moving shallow water, therefore most of our creek sites are not suitable for reproduction and are not detected in our surveys. Because we are not surveying ponds and vernal pools, western toad occupancy is estimated to be low in our study area. In fact, we detect this species in our terrestrial herpetofauna monitoring more commonly.

Detectability was fairly high for all four species, even California treefrogs (HYCA; Figure 4). California treefrogs are cryptic species that can be hard to detect as adults, and breeding occurs in a shorter window of time than the other two native species. However, in 2017 California treefrog detectability was similar to that of the ubiquitous and less cryptic Pacific treefrog.

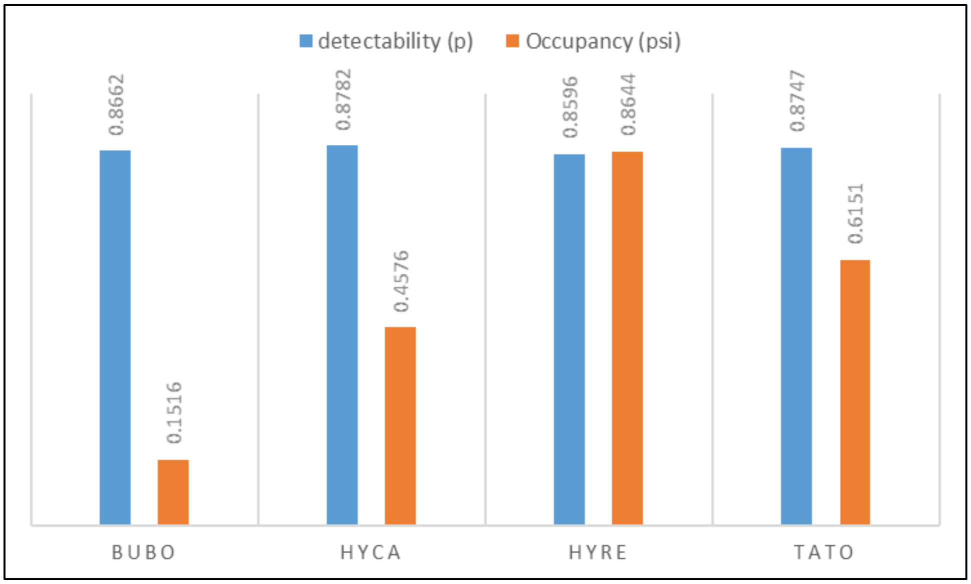

Figure 4. Single season estimate of occupancy and detectability of four native amphibians in 2017. BUBO = Western toad, FYCA = California treefrog, HYRE = Pacific treefrog, TATO = California newt.

Abundance

In 2017, the average number of Pacific treefrog (HYRE) tadpoles was 1.4 per meter (N=21, SD=1.82) for streams without crayfish and 0.26 per meter (N=9, SD=0.58) for streams with crayfish.

There was a significant difference in the average number of Pacific treefrog larvae between streams with crayfish and streams without crayfish in 2017 (Wilcoxen rank sum test: W = 155.5, p-value = 0.006). Crayfish are predatory on all life stages of amphibians and can reach very high densities. Adult and larval Pacific treefrogs are often found in smaller, side channels where crayfish are less common or absent.

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